Properties of Economic Income in a Private Information Setting*

MITCHELL A. FARLEE, *The Ohio State University*

JOHN C. FELLINGHAM, *The Ohio State University*

RICHARD A. YOUNG, *The Ohio State University*

Abstract. This paper adopts a valuation perspective within an asymmetric information setting and explores properties of economic income. The optimal intertemporal contract induces an accrual component of income which would not exist absent the information problem. The contracting solution introduces a dampening effect—if cash flow increases by one dollar, income increases by less than one dollar. Thus, the accrual is inversely related to cash flows. Further, this dampening is greater for more favorable cash outcomes.

Résumé. Les auteurs adoptent la perspective de l'évaluation en situation d'asymétrie de l'information et explorent les propriétés du bénéfice économique. Le contrat intertemporel optimal fait intervenir une amplification du bénéfice qui n'existerait pas si ce n'était de la présence du problème d'information. La solution contractuelle amène un effet atténuateur — c'est-à-dire qu'à une augmentation du flux monétaire de un dollar correspond une augmentation du bénéfice de moins de un dollar. Ainsi, l'amplification est en relation inverse avec les flux monétaires. En outre, l'atténuation est plus marquée dans le cas de résultats monétaires plus avantageux.

There exists a rich tradition of theoretical research in accounting and economics devoted to the development of a measure of firm value (and its dual, income) with desirable properties.[1] Paton (1922), Hicks (1939), Paton and Littleton (1940), Edwards and Bell (1961), Chambers (1966), Sterling (1970), and Ijiri (1975) identify properties of various approaches to measuring asset values and income. Authors in the valuation school have generally begun by

* Accepted by Joel Demski. This paper was presented at the 1995 *CAR* Conference, generously sponsored by: **Alberta's Chartered Accountants** through the **Accounting Education Foundation of Alberta,** the **Canadian Institute of Chartered Accountants,** the **Ernst & Young Foundation,** the **CGA Canada Research Foundation,** the **Peat Marwick Thorne Educational Foundation,** the **Society of Management Accountants of Canada,** and the **University of Alberta.** The authors gratefully acknowledge the helpful comments of Anil Arya, Bala Balachandran, Barry Cushing, Patricia Dechow, Ron Dye, Gary Fethke, Steve Hansen, John Hillas, Bob Magee, George Mailath, John Persons, Jamie Pratt, Doug Schroeder, Tom Stober, Gary Taylor, Peter Woodlock, and workshop participants at Indiana, Northwestern, Ohio State, and Utah. We also thank participants at the 10th *Contemporary Accounting Research* Conference and the Columbia University Accounting Research Workshop (Arden Homestead), Rick Antle, Phil Berger, Peggy Bishop, Dennis Caplan, Jerry Feltham, Michael Gibbins, Trevor Harris, Don Kirk, Mike Kirschenheiter, Nahum Melumad, Jake Thomas, Jim Xie, Amir Ziv, and two anonymous reviewers.

establishing properties of accounting numbers in markets that are perfect and complete. The analysis is then pushed in the direction of incorporating market imperfection and incompleteness.

In this paper, we also adopt a valuation perspective. We study economic income, defined as the change in the market value of an economic entity absent dividends. In the modeling exercise herein we do not derive a demand for the calculation of income. Rather, given that income is calculated, we analyze some of its properties. In particular, we are interested in the accrual (noncash) portion of income.

Our analysis differs from the tradition of the valuation school in two ways. First, we ground the analysis in an economy where information problems are formally modeled. Second, we consider only a single measure of firm value, discounted cash flow.

Our analysis also differs from that of Feltham and Ohlson (1994), who extend the theory by formally introducing uncertainty. In their model, accruals are interesting because cash flows in one period are assumed to affect cash flows in subsequent periods.

By contrast in our analysis, accruals are interesting because of information asymmetries. To highlight the result, we purposefully chose an experimental design in which cash flows in one period have no direct effect on cash flows in subsequent periods. This allows a stark consideration of the accrual portion of income measurement and its interaction with the information environment. Accruals appear because parties transact around the information asymmetry to create intertemporal effects. While inherent intertemporal dependencies in cash flows induce accrual components in income, information problems may do so as well. Of course, given our purpose it is important to make production endogenous.

To emphasize the role of the information environment, we consider a preliminary setting in which there are no information asymmetries. Without information asymmetries, there is no accrual: economic income is equal to unexpected cash flow.

Our main result is that, in a setting with information asymmetry, the equivalence of economic income and unexpected cash flow does not hold; there is a significant accrual component of income. Accruals dampen (smooth) the cash effect. That is, if the cash effect changes by \$1, the total income effect will be less than \$1. Furthermore, the amount of dampening becomes greater for more favorable cash outcomes. As a result, accruals and cash flows are negatively correlated.

In the next section, we present a simple one-period asymmetric information model. The risk-neutral owner's optimal contract restricts production to extract the manager's information rents. Section three extends the model to two periods and derives optimal contracts. Long term arrangements, that is, those that make second-period decisions dependent on first-period realizations, are optimal because they increase production. Having formally dealt with economic frictions, in the fourth section we focus on properties of economic income. Section five concludes the paper.

One period model

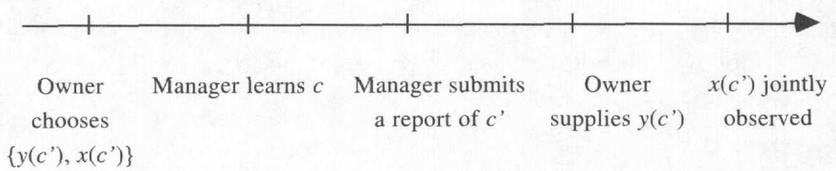
Our main concern is exploring properties of accounting in a friction-laden economy. Construction of a rich but focused model is a delicate exercise. Parsimony motivates our choice of linear preferences and production functions. However, interesting accounting implications require the presence of market frictions that can be mitigated by an ongoing arrangement. We choose an information-induced friction.

The owner (principal) and the manager (agent) are risk neutral, and the manager must obtain funds for production from the owner. This restriction, which we refer to as resource feasibility, gives rise to the agency and could be interpreted as a case where the manager has insufficient wealth to post a bond or his liability is limited by law (Antle and Eppen 1985; Antle and Fellingham 1990; Sappington 1983). The resource feasibility constraint effectively rules out selling the firm to the manager. Resource feasibility, when combined with the manager's private information, gives rise to contracting frictions.

The output x is constrained to be less than one, and the price of output is normalized to one. At the time of contracting, the owner does not know, nor can she later verify, the constant marginal cost c. She has, however, a common knowledge prior density function on the cost, denoted $f(c) > 0$, $c \in [0, 1]$. In contrast, we assume the manager has perfect private predecision information about c. The cost c can be interpreted as a personal cost of the manager, for which he must be compensated. We further assume any funds not needed to generate the requested output can be consumed by the manager as slack (perquisites).[2] This gives the manager incentives to overstate the cost. Under this interpretation, one may state the resource feasibility as follows: the manager's slack must be non-negative.

We assume that prior to production the manager provides the owner with a report (possibly interpreted as a budget) c' regarding the marginal cost. Anticipating this, the owner commits to a contract consisting of two functions that describe (1) the amount of funding $y(c')$ and (2) the output to be consumed by the owner $x(c') \leq 1$. Having assumed a linear cost function, the minimum required investment in state c to produce $x(c')$ is equal to $c\,x(c')$, so the manager's slack is equal to $y(c') - c\,x(c')$. Figure 1 summarizes the sequence of events.

Figure 1 Timeline—one-period model



A formal statement of the owner's contracting problem (P1) follows.

$$\max_{x(c),\, y(c)} \int_0^1 [x(c) - y(c)] f(c)\, dc \qquad \text{(P1)}$$

subject to:

$$y(c) - c\,x(c) \geq y(c') - c\,x(c') \qquad \forall\, c, c' \qquad \text{(TT-1)}$$

$$y(c) \geq c\,x(c) \qquad \forall\, c \qquad \text{(RF–1)}$$

$$0 \leq x(c) \leq 1 \qquad \forall\, c \qquad \text{(OF–1)}$$

The owner anticipates rational reporting behavior on the part of the manager, that is, the contract is designed to be incentive compatible. Given the structure of the model (and without loss of generality), incentive compatibility may be satisfied by making it optimal for the manager to issue a truthful report (Myerson 1979). The truth-telling constraints (TT-1) require that the manager's slack from reporting honestly in state c be at least as large as if he, say, "padded the budget" by reporting some $c' > c$.

Given that (TT-1) are satisfied, the objective function and the remaining constraints can be written assuming reporting is honest; that is, $c' = c$. The objective function is the owner's expected utility (residual). The constraint that investment funds must come from the owner are formally represented by the resource feasibility constraints (RF-1). The output feasibility constraints (OF-1) ensure the output is non-negative and does not exceed its upper bound. We further assume that the manager is willing to participate in the agency as long as his expected slack is non-negative.[3] Thus, any expected slack received by the manager under the solution to (P1) has the interpretation of economic rents.

The symmetric information solution sets $y(c) = c$ and $x(c) = 1$ and production is efficient. Note that if either the resource feasibility or truth-telling constraints are absent, the symmetric information solution would be achieved. An optimal solution when the (RF-1) constraints are not present pays the manager the expected cost and demands full production for all cost reports. In expectation, the owner pays no slack. This solution satisfies truth-telling but violates the (RF-1) constraints for sufficiently high costs. An optimal solution when (TT-1) are not present pays the manager just enough to cover the true cost, $y(c) = c\,x(c)$, and demands full production for all cost reports. The owner pays no slack. This solution satisfies resource feasibility but violates the truth-telling constraints.

Lemmas 1 and 2 demonstrate that due to information asymmetry production is restricted. (Proofs contained in the Appendix.[4])

Lemma 1

For any incentive compatible contract, there exists a "cutoff" $k \in [0, 1]$ such that the following condition holds:

(i) $x(c)$ is non-increasing,

(ii) $x(c) > 0,\ c \leq k$,

(iii) $x(c) = 0$, $c > k$, where $k \leq 1$.

Lemma 1 states that truth-telling alone implies the contract involves (at most) two regions, a low-cost region of the reports in which production is positive and a high-cost region in which production does not occur. The intuition for Lemma 1 is that if $x(c)$ were increasing in a neighborhood it would be impossible to satisfy incentive compatibility for both higher and lower costs in that neighborhood. For example, if c' and c both satisfy truth-telling, the cost is $c < c'$, and $x(c)$ were increasing, the manager would falsely claim the cost is c'.

Lemma 2

The optimal solution to (P1) is characterized as follows:

$$y(c) = k^*, \text{ where } k^* < 1, \qquad x(c) = 1, \qquad c \leq k^*,$$

$$y(c) = 0, \quad x(c) = 0, \qquad c > k^*,$$

where k^* satisfies the first-order condition:

$$1 - k^* - \frac{F(k^*)}{f(k^*)} = 0. \tag{1}$$

Lemma 2 states that when the reported cost is less than or equal to k, the owner provides k dollars to the manager and requests output equal to 1. Otherwise, the owner provides no funds and requests no output. Thus, the manager receives slack if and only if $c < k^*$.[5] Lemma 2 further implies the owner can achieve a higher residual by restricting production.

Inspection of the first-order condition (1) reveals that the owner's information disadvantage implies that to increase production she must pay additional slack (a distributional effect).[6] Marginal decreases in the cutoff (from $k = 1$) decrease production by $(1 - k) f(k) = (1 - 1) f(1) = 0$, but decrease the manager's slack by $F(k) = F(1) = 1 > 0$. Thus, the owner can improve her welfare by committing to inefficient production. At an optimum, the owner sets k^* so as to equalize the distributional and efficiency effects.

We now present a numerical example. Assume c follows the uniform density on [0, 1]. Equation 1 can be used to solve for k^*. Table 1 summarizes the optimal contract and illustrates that (1) it is optimal for the owner to set k below 1 and (2) the owner is worse off due to information asymmetry.

TABLE 1
One period example—uniform distribution

Asymmetric information			Symmetric information		
k	Owner's residual	Manager's residual	y	Owner's residual	Manager's residual
$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	c	$\frac{1}{2}$	0

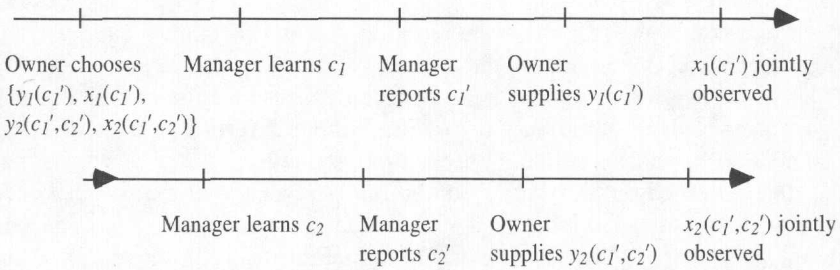
Two period model

The existence of inefficient production, as demonstrated in the one-period model, is necessary for a multiperiod relationship to yield social improvements. Furthermore, a multiperiod model is necessary for the study of accounting phenomena. We now present a simple two period extension of that model.

Denote the cost of production in period i by c_i, i = 1, 2. To focus on intertemporal effects caused by information asymmetry, we assume c_1 and c_2 are statistically independent and have identical densities $f(\cdot)$, $c_i \in [0, 1]$.[7] Thus, at the time the manager provides a report regarding c_1, the manager and the owner have the same beliefs about c_2. However, subsequent to reporting c_1 (and prior to producing the second time), the manager learns c_2.

If the owner and manager were to undertake a continuing relationship, they would write a two period contract that specifies the functions: $\{y_1(c_{1'}), x_1(c_{1'}), y_2(c_{1'},c_{2'}), x_2(c_{1'},c_{2'})\}$. A time line is featured in Figure 2. Note that the manager's expected future slack potentially depends on his current report, because $y_2(c_{1'},c_{2'})$ may be a function of $c_{1'}$.

Figure 2 Timeline—two-period model



The owner faces the same sorts of constraints within the two-period setting. The manager's reporting behavior must be incentive compatible, and the revelation principle holds. Further, on a period-by-period basis, the owner must pay the manager at least as much as the cost of production. Output feasibility is still required.

The program to solve for an optimal contract can be simplified considerably. (The unsimplified program is provided in the appendix.) The owner's and manager's problems in the second period are similar to their problems in the one period model because (1) c_1 and c_2 are independent, (2) the owner is risk neutral, and (3) the manager's second period payment must satisfy resource feasibility. The logic used in the proof of Lemmas 1 and 2 can be applied to show that (1) a cutoff strategy is used in period 2 such that for $c_2 \leq k_2(c_1)$, $x_2(c_1,c_2) = 1$ and $y_2(c_1,c_2) = k_2(c_1)$; otherwise $x_2(c_1,c_2) = y_2(c_1,c_2) = 0$, where $k_2(c_1)$ represents the second period cutoff (which may depend on first period cost) and (2) there are two regions of c_1, one in which $x_1(c_1) = 1$ and another in which $x_1(c_1) = 0$.

We in addition require that the contract be renegotiation-proof. That is, there are no realizations of c_1 for which both the owner and manager would agree to abandon the two period contract in favor of an optimal one period contract. Because a cutoff strategy is used in the second period of the two period contract, the only time both parties would like to renegotiate is when k_2 is less than k^*.[8] Thus, we append the following constraint.

$$k_2(c_1) \geq k^* \tag{RP}$$

We next demonstrate that the owner's problem is relaxed by her ability to commit to future production decisions. Given that a cutoff strategy is optimal in period 2 and that production is one or zero in period 2, (TT1-2) can be written as follows.

$$y_1(c_1) + \int_0^{k_2(c_1)} [k_2(c_1) - c_2] f(c_2)\, dc_2 = \text{constant} \tag{2}$$

Equation 2 states that truth telling is equivalent to making the manager's first-period payment plus expected future slack equal to a constant, where the constant depends on whether c_1 is in a producing or non-producing region. In the two-period setting, it is possible for the owner to make the manager's first period payment conditional on c_1 if she also commits to make the second period cutoff conditional on c_1.

Lemma 3 says something precise about the optimal way to use the manager's report.

Lemma 3
If there exists a region of the cost $a_L \leq c_1 \leq a_H$ in which $y_1(c_1)$ is nonconstant, an optimal contract can be written so as to satisfy:

(i) If $c_1 \leq a_L$, $y_1(c_1) = a_L$, $x_1(c_1) = 1$, and $k_2 = 1$;

(ii) If $a_L \leq c_1 \leq a_H$, $y_1(c_1) = c_1$, $x_1(c_1) = 1$, and k_2 satisfies $\frac{dk_2}{dc_1} = -\frac{1}{F(k_2(c_1))}$;

(iii) If $c_1 \geq a_H$, $y_1(c_1) = 0$, $x_1(c_1) = 0$, and $k_2 = k^*$.

Lemma 3 states that if $y_1(c_1)$ is non-constant in an interval, it is optimal to set $y_1(c_1) = c_1$, that is, to eliminate all slack in period one. Condition (ii) in Lemma 3 implies that if the owner makes the first period payment and second period cutoff a function of the c_1, it is optimal to establish a region in which the manager receives no slack in period one. Thus, finding the optimal contract consists of choosing three variables: the function $k_2(c_1)$ and constants a_L and a_H which bound the region in which $y_1(c_1) = c_1$ and k_2 is interior. We note that we have not yet established that an optimal contract requires setting $y_1(c_1)$ nonconstant.

Lemma 3 can be now used to simplify the owner's objective function;

$$\int_0^{a_L}[1-a_L]f(c_1)\,dc_1+\int_{a_L}^{a_H}[1-c_1]\,f(c_1)\,dc_1+$$

$$\int_{a_L}^{a_H}\int_0^{k_2(c_1)}[1-k_2(c_1)]f(c_2)\,dc_2\,f(c_1)\,dc_1+\int_{a_H}^{1}\int_0^{k^*}[1-k^*]f(c_2)\,dc_2\,f(c_1)\,dc_1$$

where $k_2(c_1)$ is given by Lemma 3. Proposition 1 characterizes an optimal contract.

Proposition 1

Under an optimal contract there exist constants a_L and a_H such that $a_L < a_H$. Proposition 1 is important because it is equivalent to stating that long term contracts are always optimal. To explain, a two period contract which is composed of consecutive optimal one period contracts is equivalent to $a_L = a_H = k^*$. Inspecting Lemma 3, $y_1(c_1) = k^*$ for $c \le k^*$ and 0 otherwise, and $k_2(c_1) = k^*$ for all c_1. Such contracts are *myopic*; they of course satisfy equation 2. In a myopic contract, second period payment and production are independent of the first-period cost report.

A *long term* contract is one in which $y_1(c_1)$ and $k_2(c_1)$ must depend on c_1. From conditions (i) - (iii) of Proposition 1 this occurs if and only if $a_L \neq a_H$. Since by the proposition $a_L < a_H$, a long term contract is strictly preferred to a myopic contract.

The intuition for why long term contracts are beneficial is that increases in the second-period cutoff above the optimal one period cutoff k^* have no first-order effect on expected two-period slack but do lead to first-order increases in production.[9] That is, slack can be shifted from the firstperiod into the second period, resulting in increased second-period production without a corresponding increase in expected slack. As a result, a nontrivial relationship between second period production decisions and first period communication is optimal.

We illustrate an optimal contract using the numerical example introduced earlier. Assume that in each period c_i follows the uniform density on [0, 1]. The Appendix describes the approach used to get a closed form solution.

Table 2 and Figure 3 illustrate Proposition 1. Production exceeds what would be obtained via two optimal myopic contracts, since $a_H > \frac{1}{2}$ and $k_2 \geq \frac{1}{2}$ for all c_1.

TABLE 2
Two period optimal contract

Optimal (Long Term) contract					Myopic contract		
a_L	a_H	$\{k_2(c_1) \mid a_L \le c_1 \le a_H\}$	Owner's residual	Manager's residual	k^*	Owner's residual	Manager's residual
$\frac{3}{16}$	$\frac{9}{16}$	$\sqrt{\frac{11}{8} - 2c_1}$	$\frac{425}{768} \approx 0.553$	$\frac{145}{512} \approx 0.283$	0.5	0.5	0.25

Three features of the model combine to create multiperiod effects, which in turn lead to potentially interesting accounting phenomena. First, the manager is uncertain about the second period cost when he communicates the first-period cost. Second, the owner can commit to do things that are not sequentially rational based on the manager's first-period communication. In particular, the owner commits to produce more than she would in a one period contract. A rough interpretation is that, under a long term contract, the manager receives a stake in the firm, making it possible to better align incentives. Third, the contract must satisfy resource feasibility constraints in each period. This prevents the owner from eliminating all second period productive inefficiencies, and hence interesting multiperiod effects follow.[10]

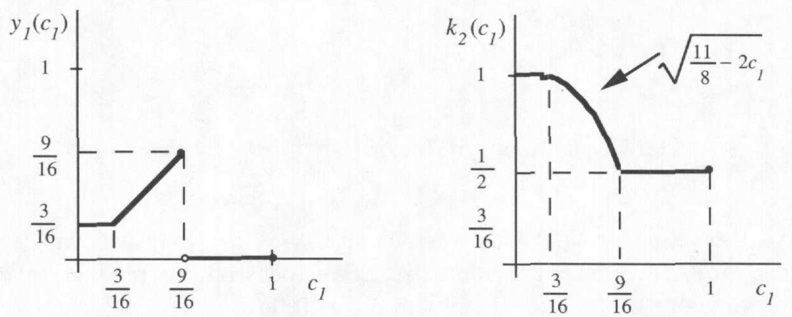
Economic income and properties of accruals

In this section, we study the behavior of economic income within the model. Optimally contracting around information asymmetries induces a systematic relationship between cash flows and accruals.

Accounting activities can be classified into two distinct parts: (1) cash accounting and (2) accruals designed to adjust for changes in the value of non-cash assets and liabilities. Cash accounting is straightforward—determination of the accrual portion is the delicate and challenging aspect of the accountant's art.

We do the accounting as follows. Asset values are assumed to be equal to expected future cash flows (we ignore discounting for exposition purposes). Time zero value consists of two accruals, one for each period's investment opportunity. Time one value consists of the cash flow from period one plus the accrual for the period two investment opportunity. Time two value equals cash. Thus, at each point in time accounting values are equal to what a risk neutral agent would be willing to pay for the assets.

Figure 3 First-period investment and second period cutoff



Income is defined in the usual (clean surplus) fashion: the dividend-adjusted change in the value of net assets (but we ignore dividends for exposition purposes). Because the owner is risk neutral, when the accounting is done in this way income is a measure of the change in the owner's welfare. Thus we refer to it as economic income. Economic income can be separated into two components: the unexpected cash flow in that period plus the change in expected future cash flows.

Symmetric information

It is instructive to first explore the symmetric information case as a benchmark to evaluate the asymmetric information case. Under symmetric information, value at time zero (V_0^{SI}) and one (V_1^{SI}) and income during period one (I_1^{SI}) are as follows.

$$V_0^{SI} = \int_0^1 [1 - c_1] f(c_1)\, dc_1 + \int_0^1 [1 - c_2] f(c_2)\, dc_2$$

$$V_1^{SI}(c_1) = 1 - c_1 + \int_0^1 [1 - c_2] f(c_2)\, dc_2$$

$$I_1^{SI}(c_1) = V_1^{SI}(c_1) - V_0^{SI} = 1 - c_1 - \int_0^1 [1 - c_1] f(c_1)\, dc_1$$

Under symmetric information, the investment decision made at time two is unaffected by the realization of c_1. Thus, there is no change in expected future cash flows related to the second investment opportunity: income in period one is simply equal to the unexpected cash flow from period one. If we define cash flow as $CF = (1\text{-}c_1)$, another way to state this result is as follows: $\frac{dI}{dCF} = 1$.

Asymmetric information

Under asymmetric information, value at time zero is equal to the owner's objective function.

$$V_0^{AI} = \int_0^{a_L} [1 - a_L] f(c_1)\, dc_1 + \int_{a_L}^{a_H} [1 - c_1]\, f(c_1)\, dc_1 +$$

$$\int_{a_L}^{a_H} \int_0^{k_2(c_1)} [1 - k_2(c_1)] f(c_2)\, dc_2 f(c_1)\, dc_1 + \int_{a_H}^{1} \int_0^{k^*} [1 - k^*] f(c_2)\, dc_2 f(c_1)\, dc_1$$

All the action occurs in the region: $a_L \le c_1 \le a_H$. For such values, k_2 depends on c_1 according to Lemma 3 (ii). We focus on this region, wherein value at time one and period one income are as follows.

$$V_1^{AI}(c_1) = 1 - c_1 + \int_0^{k_2(c_1)} [1 - k_2(c_1)] f(c_2)\, dc_2$$

$$I_1^{AI}(c_1) = V_1^{AI}(c_1) - V_0^{AI} =$$

$$1 - c_1 - \left\{ \int_0^{a_L} [1 - a_L] f(c_1)\, dc_1 + \int_{a_L}^{a_H} [1 - c_1]\, f(c_1)\, dc_1 \right\}$$

$$+ \int_0^{k_2(c_1)} [1 - k_2(c_1)] f(c_2) dc_2 - \left\{ \int_{a_L}^{a_H} \int_0^{k_2(c_1)} [1 - k_2(c_1)]\, f(c_2) dc_2 f(c_1) dc_1 + \int_{a_H}^{1} \int_0^{k^*} [1 - k^*] f(c_2) dc_2 f(c_1) dc_1 \right\}$$

The first line in the expression for $I_1^{AI}(c_1)$ is the unexpected cash flow from period one investment. The second line is the change in expectations (and the net accrual) for the second period investment opportunity.

Under asymmetric information, the investment decision made at time two _is_ affected by the realization of c_1. Thus, the resolution of uncertainty about c_1 prompts a change in expected future cash flows related to the second investment opportunity. Income in period one is equal to the unexpected cash flow from period one _plus_ the change in expectations regarding the second-period cash flows. Under asymmetric information, it is now false that $\frac{dI}{dCF} = 1$. This suggests that the presence of private information (and attempts to contract around it) makes the accrual activity a delicate exercise.

Proposition 2 further describes properties of the relationship between income and cash flows.

Proposition 2
Assume the hazard rate $\frac{F(c)}{f(c)}$ is increasing.[11] Then for $a_L < c_1 < a_H$, period one income and cash flow are related in the following fashion:

$$0 < \frac{dI}{dCF} < 1$$

$$\frac{d^2 I}{dCF^2} < 0.$$

The derivative of the cash flow component of income is 1, and so the derivative of the accrual component is negative. Thus, the accrual effect dampens the cash flow effect. In addition, the accrual component is concave in cash flow. Thus, the marginal dollar of cash flow affects income less when the level of cash flow is high.

Income smoothing involves selective use of accruals to reduce income when performance is good and increase income when performance is poor. In our model, when cash flow is high the accrual is low, but this relationship is driven by the contracting solution to the information problem, and not by nefarious attempts to manipulate income. In fact, the "smoothing" of cash with accruals is required to equate value and discounted cash flows.

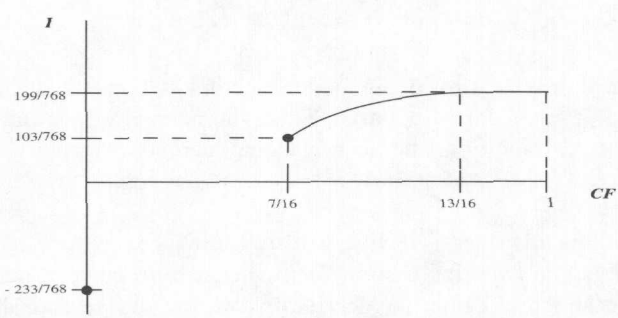
The solution to the numerical example (Table 2) is used to illustrate Proposition 2. Table 3 provides the time one balance sheet, which depends on which value of c_1 obtains. The investment and the payment to the manager are accounted for separately.

TABLE 3
Balance sheet at time one

Cost	$0 \le c_1 \le \frac{3}{16}$	$\frac{3}{16} \le c_1 \le \frac{9}{16}$	$\frac{9}{16} < c_1 \le 1$
Cash flow	$CF = \frac{13}{16}$	$\frac{7}{16} \le CF \le \frac{13}{16}$	$CF = 0$
Cash	$\frac{13}{16}$	$1 - c_1$	0
Investment	1	$\sqrt{\frac{11}{8} - 2c_1}$	$\frac{1}{2}$
Salary payable	1	$\frac{11}{8} - 2c_1$	$\frac{1}{4}$
Owner's equity	$\frac{13}{16}$	$c_1 - \frac{3}{8} + \sqrt{\frac{11}{8} - 2c_1}$	$\frac{1}{4}$

In each region income is equal to owner's equity at time one minus $\frac{425}{768}$, the owner's equity at time zero. The nature of the optimal contract implies that income can take on the value $-\frac{233}{768}$ (when c_1 exceeds $\frac{9}{16}$ period one cash flow is zero) or values between $\frac{103}{768}$ and $\frac{199}{768}$ (when c_1 is less than $\frac{9}{16}$ period one cash flow exceeds $\frac{7}{16}$). ubstituting $c_1 = 1 - CF$ into the owner's equity expression, the relationship between period one income and cash flow is illustrated in Figure 4.

Figure 4 Income = $\frac{5}{8} - CF + \quad 2CF - \frac{5}{8} - \frac{425}{768}$



It may be instructive to compare the structure of our accruals with those that follow from the usual technological assumptions about intertemporal cash flows. In our model, information asymmetries induce a dampening phenomena. Future expected cash flows decrease as present cash flows increase. Under an economic income approach, contemporaneous accruals and cash flows are thus negatively correlated. In contrast, typical technological assumptions are that, as present cash flows increase, future cash flows increase. Therefore, under an economic income approach, contemporaneous accruals and cash flows would be positively correlated.[12] Because an information problem such as ours induces a relationship between accruals and cash flows opposite to that implied by the typical technological assumption, it may be problematic for empirical tests based on published accounting numbers to distinguish the two effects. In documenting relationships between cash flows and accruals, it may be useful to partition the data according to the extent to which one phenomena is expected to dominate.

Conclusions and discussion

Accounting scholars have long acknowledged that the accountant's role is in valuing assets whose value is not easily determined:

> [A]ccounting may be said to deal with the determination of values. The laws of the market, the principles of demand and supply, are matters with which the accountant is only indirectly concerned, but it is his business to redetermine, in a manner not inconsistent with current market processes and from the point of view of the individual enterprise, the values of specific items that have disappeared from the market and constitute a part of the capital of the particular enterprise. (Paton 1922, 10)

This paper represents a preliminary step toward understanding properties of accounting in settings characterized by market frictions. In such settings, accounting may be more difficult (and more interesting).

Similar to Feltham and Ohlson (1994), we assume discounted cash flow valuation and clean surplus income measurement and track economic income and accruals over time. Our approach is nevertheless different than that in Feltham and Ohlson, because we purposefully construct the model so information problems alone drive an intertemporal relationship between cash flows. We demonstrate that accruals are decreasing and concave in cash flows.

It is a valid question to ask what implications our work has for the practice of accounting. Suppose that accounting income was intended to convey improvement in owner's welfare, that is, economic income. Then our analysis suggests the estimation of the accrual portion of income introduces significant complications into the accounting. Information problems alone may cause accounting accruals to become contingent on cash flows. Because of the structure of our model, we were able to learn something about how and why the accruals depend on cash flows.

Our focus on economic income limits comparisons to income calculated under generally accepted accounting principles. However, the two concepts of income are not entirely noncomparable. Economic income possesses a "more is better" property. Presumably at least some accounting policies are constructed with the objective of preserving the more-is-better property. Further, there may be some similarities between the two income concepts induced by the structure of the double entry system. This concept was addressed by Edwards and Bell (1961). More recent examples include Feltham and Ohlson (1994) (Proposition 4) and Fellingham, Finger, Teets, and Ziebart (1995) (Proposition 2), who establish conditions under which accounting income equals economic income in expectation. In both cases, the expectational equivalence is established without imposing that accounting book value equal market value.

Our results have implications for the role of market values in accounting. Commonly, market valuation (mark-to-market) is meant engaging in a survey of the environment to discover similar assets to which objective market values are attached. Under information asymmetries, the surveying activity may not be helpful. As we have shown, an important part of the asset's value may be determined purely by the information setting in which it resides, as well as by how the uncertainty is resolved! Finding similar assets for comparison purposes means finding similar information environments, a much more formidable task than establishing physical similarity.

Appendix

Proof of Lemma 1: To prove that if a nonproducing region exists, it is for an upper interval of costs, it is sufficient to prove $x(c)$ is nonincreasing. The proof is by contradiction. Assume $x(c') > x(c'')$ and $c' > c''$ ($x(c)$ increasing). Then truth-telling implies:

(i) $y(c') - c'x(c') \geq y(c'') - c'x(c'')$

(ii) $y(c'') - c''x(c'') \geq y(c') - c''x(c')$.

Rewrite (i) and (ii) to read:

(i') $y(c') \geq y(c'') - c'x(c'') + c'x(c')$

(ii') $y(c'') - c''x(c'') + c''x(c') \geq y(c')$.

Conditions (i') and (ii') imply $y(c'') + c''[x(c') - x(c'')] \geq y(c'') + c'[x(c') - x(c'')]$, which contradicts that $c' > c''$. Thus, there are two regions; produce for all $c \leq k$ (where $x(c)$ is nonincreasing), and do not produce for all $c > k$ ($x(c) = 0$).

Proof of Lemma 2: Let $U(c)$ denote the manager's slack if he honestly reports his state, that is:

$U(c) = y(c) - c\,x(c)$. Truth telling implies inequality (A1) below.

$$U(c) - U(c') = y(c) - c\,x(c) - [y(c') - c'\,x(c')]$$

$$\geq y(c') - c\,x(c') - [y(c') - c'\,x(c')] = (c' - c)\,x(c') \qquad \text{(A1)}$$

Interchanging the roles of c and c' and using truth telling provides inequality (A2):

$$U(c') - U(c) = y(c') - c'\,x(c') - [y(c) - c\,x(c)]$$

$$\geq y(c) - c'\,x(c) - [y(c) - c\,x(c)] = (c - c')\,x(c), \text{ or}$$

$$U(c) - U(c') \leq (c' - c)\,x(c) \tag{A2}$$

Combining (A1) and (A2) provides:

$$(c' - c)\,x(c') \leq U(c) - U(c') \leq (c' - c)\,x(c).$$

Next divide by $c' - c$ and take the limit as c' approaches c to produce:

$\frac{dU(c)}{dc} = -\,x(c)$. Integrate to yield:

$$dU = -x(c')\,dc'$$

$$\int_0^c dU = \int_0^c -x(c')\,dc'$$

$$U(c) - U(0) = \int_0^c -x(c')\,dc'$$

$$U(c) = U(0) + \int_0^c -x(c')\,dc'.$$

Note that $U(0) = y(0)$, and set $U(c) = y(c) - c\,x(c)$ to provide:

$$y(c) = y(0) + c\,x(c) + \int_0^c -x(c')\,dc'.$$

Let k denote the largest value of c such that $x(c) > 0$. Truth telling across regions and piecewise continuity further implies that $Y = y(k) - k\,x(k)$, so:

$$Y = y(0) + k\,x(k) + \int_0^k -x(c')\,dc' - k\,x(k) = y(0) - \int_0^k x(c')\,dc'$$

Now substitute for $y(c)$ into the owner's objective function.

$$\int_0^k [x(c) - y(c)] f(c)\, dc - \int_k^1 Y f(c)\, dc =$$

$$\int_0^k \left[x(c) - \left\{ y(0) + c\, x(c) - \int_0^c x(c')\, dc' \right\} \right] f(c)\, dc$$

$$- \int_k^1 y(0) f(c)\, dc + \int_k^1 \int_0^k x(c')\, dc' f(c)\, dc$$

$$= \int_0^k [x(c) - c\, x(c)] f(c)\, dc + \int_0^k \int_0^c x(c')\, dc' f(c)\, dc - y(0) + \int_k^1 \int_0^k x(c')\, dc' f(c)\, dc$$

The order of integration of the second and third terms can be reversed to provide:

$$\int_0^k \int_0^c x(c')\, dc' f(c)\, dc = \int_0^k x(c)\, [F(k) - F(c)]\, dc,$$

$$\text{and} \int_k^1 \int_0^k x(c')\, dc' f(c)\, dc = \int_0^k x(c)\, [1 - F(k)]\, dc.$$

So the objective function, which is to be maximized over $x(c)$, k and $y(0)$, can be written as follows.

$$\int_0^k [x(c) - c\, x(c)] f(c)\, dc + \int_0^k x(c)\, [1 - F(c)]\, dc - y(0)$$

$$= \int_0^k x(c) \left[1 - c + \frac{1 - F(c)}{f(c)} \right] f(c)\, dc - y(0)$$

The integrand is linear in $x(c)$. Because the term in braces is always positive, point-by-point maximization implies $x(c) = 1$ for all $c \leq k$. But $x(c) = 1$ and truth-telling imply $y(c)$ is constant. Optimality considerations dictate that resource feasibility binds, so $y(c) = k$ for all $c \leq k$, and in particular at $c = 0$, that is, $y(0) = k$.

Substituting $x(c) = 1$ and $y(0) = k$, the derivative of the objective function with respect to k is:

$$[1 - k + \frac{1 - F(k)}{f(k)}]\, f(k) - 1 = [1 - k - \frac{F(k)}{f(k)}]\, f(k).$$

The derivative is negative at $k = 1$, which implies $k^* < 1$. Note that the objective function is zero at the boundaries ($k = 0$ and $k = 1$) and continuous, so the optimum is interior and the first-order condition is necessary.

Two period program

The owner's program (P2) includes first-and second-period truth telling constraints ([TT1-2], [TT2-2]), resource feasibility constraints ([RF1-2],[RF2-2]) and output feasibility constraints (OF-2). Note that the manager's expected future slack potentially depends on his current report, because $y_2(c_{1'},c_{2'})$ may be a function of $c_{1'}$.

$$\max_{\substack{x_1(c_1),y_1(c_1)\\ x_2(c_1,c_2),\, y_2(c_1,c_2)}} \int_0^1 [x_1(c_1) - y_1(c_1)]\, f(c_1)\, dc_1 + \int_0^1\int_0^1 [x_2(c_1,c_2) - y_2(c_1,c_2)]\, f(c_1)\, f(c_2) dc_1 dc_2 \quad \text{(P2)}$$

subject to:

$$y_1(c_1) - c_1\, x_1(c_1) + \int_0^1 [y_2(c_1,c_2) - c_2\, x_2(c_1,c_2)]\, f(c_2)\, dc_2$$

$$\geq y_1(c_1') - c_1\, x_1(c_1') + \int_0^1 [y_2(c_1',c_2) - c_2\, x_2(c_1',c_2)]\, f(c_2)\, dc_2 \qquad \forall\, c_1,\, c_1' \qquad \text{(TT1–2)}$$

$$y_2(c_1,c_2) - c_2 x_2(c_1,c_2) \geq y_2(c_1,c_2') - c_2\, x_2(c_1,c_2') \qquad \forall\, c_1,\, c_2,\, c_2' \qquad \text{(TT2–2)}$$

$$y_1(c_1) \geq c_1\, x_1(c_1),\;\; y_2(c_1,c_2) \geq c_2\, x_2(c_1,c_2) \qquad \forall\, c_1,\, c_2 \qquad \text{(RF–2)}$$

$$0 \leq x_1(c_1),\, x_2(c_1,c_2) \leq 1 \qquad \forall\, c_1,\, c_2 \qquad \text{(OF–2)}$$

The resource feasibility constraints assume the manager consumes the first-period slack. If the manager could somehow be forced to save, resource feasibility would be written as follows.

$y_1(c_1) \geq c_1\, x_1(c_1)$

$y_1(c_1) - c_1\, x_1(c_1) + y_2(c_1,c_2) \geq c_2\, x_1(c_1,c_2)$

The optimal solution identified below remains optimal under this version of resource feasibility as well. Any feasible contract which satisfies these constraints can be rewritten so $y_1(c_1) = c_1\, x_1(c_1)$, by shifting any first-period slack to period two. In that case, the resource feasibility constraints in the program are satisfied.

Proof of Lemma 3: The first-period truth telling conditions (TT1-2) are equivalent to equation (2):

$$y_1(c_1) + \int_0^{k_2(c_1)} [k_2(c_1) - c_2]\, f(c_2)\, dc_2 = \text{constant} \qquad (2)$$

Taking the derivative of both sides with respect to c_1 provides:

$$\frac{dy_1}{dc_1} = -\frac{dk_2}{dc_1} F(k_2). \qquad \text{(A3)}$$

We maximize the owner's expected utility at each c_1 (point-by-point):

$$1 - y_1(c_1) + \int_0^{k_2(c_1)} [1 - k_2(c_1)] f(c_2)\, dc_2.$$

Because k_2 is a function of y_1 through expression (A3), let $u(y_1, k_2(y_1))$ denote the owner's expected utility at each c_1. Now take the total derivative of u with respect to y_1, providing:

$$\frac{du}{dy_1} = \frac{\delta u}{\delta y_1} + \frac{\delta u}{\delta k_2}\frac{dk_2}{dy_1} = -\frac{(1-k_2(c_1))\, f(k_2(c_1))}{F(k_2(c_1))} < 0.$$

Therefore it is optimal to decrease y_1 until resource feasibility is binding, that is to set $y_1(c_1) = c_1$. Substituting this result into (A3) provides the result: $\frac{dk_2}{dc_1} = -\frac{1}{F(k_2(c_1))}$. Region (i) appears if at some c the value of k_2 that solves this differential equation exceeds 1, in which case $y_1 = a_L$ and $k_2 = 1$. Region (iii) appears if at some c the value of k_2 that solves this differential equation is less than k^*, in which case $y_1 = 0$ and $k_2 = k^*$.

Proof of Proposition 1: From Lemma 3, a long term contract is equivalent to setting $y_1(c_1) = c_1$ for $a_L \le c_1 \le a_H$. The proof shows that for any a_L and a_H, the owner's welfare is increased by decreasing a_L. Because repeated optimal one period contracts are equivalent to setting $a_L = a_H = k^*$ (which are interior values of a_L and a_H), they can be improved by creating a region where first-period communication is used in a nontrivial way. The owner's expected utility is the following expression:

$$\int_0^{a_L} [1 - a_L] f(c_1)\, dc_1 + \int_{a_L}^{a_H} [1 - c_1] f(c_1)\, dc_1 + \int_0^{a_L}\int_0^{k_2(a_L)} [1 - k_2(a_L)] f(c_2)\, dc_2\, f(c_1)\, dc_1 \qquad (3)$$

$$+ \int_{a_L}^{a_H}\int_0^{k_2(c_1)} [1 - k_2(c_1)] f(c_2)\, dc_2\, f(c_1)\, dc_1 + \int_{a_H}^{1}\int_0^{k_2(a_H)} [1 - k_2(a_H)] f(c_2)\, dc_2\, f(c_1)\, dc_1.$$

Taking the derivative with respect to a_L and substituting $\frac{dk_2}{dc_1} = -\frac{1}{F(k_2(c_1))}$ provides: $-\frac{[1-k_2(a_L)f(k_2(a_L))F(a_L)}{F(k_2(a_L))} < 0$ at $a_L = k^*$. Thus, the owner's expected utility strictly increases from a marginal decrease in a_L, that is, from using a long term contract. The contract takes the form from Lemma 3, with $a_L < k^*$.

Uniform distribution example—two period contract
Under the uniform distribution on [0,1], $F(c_1) = c_1$. Lemma 2 (equation (1)) implies that the one-period solution is $k^* = \frac{1}{2}$. To solve for the optimal two-period contract, first use Lemma 3 (ii) to obtain $\frac{dk_2}{dc_1} = -\frac{1}{k_2}$. Solving the differential equation provides $k_2(c_1) = \sqrt{A-2c_1}$, where A is a constant of integration. Then substitute this expression for k_2 and $f(\cdot) = 1$ into the expression for the owner's expected utility (see the proof of Proposition 1) and integrate over c_1 and c_2 to yield:

$$\phi(a_L, a_H, A) = \frac{a_L^2}{2} + 3\,a_H - \frac{3}{2}\,a_H^2 - A + a_L\sqrt{A-2a_L}$$

$$+ (1-a_H)\sqrt{A-2a_H} + \frac{1}{3}(A-2a_L)^{3/2} - \frac{1}{3}(A-2a_H)^{3/2}$$

The general optimization procedure involves checking the extreme points for local maxima and checking for global optima by comparing any local maxima to all boundary solutions.

The proof first shows by contradiction that (RP) is binding. Let f_i denote partial derivative of the owner's residual with respect to the i^{th} argument. Assume (RP) is not binding, then a solution satisfying the following conditions is an interior extreme point.

$$\phi_1 = a_L\left[1 - \frac{1}{\sqrt{A-2a_L}}\right] = 0 \qquad \phi_2 = 3(1-a_H) - \frac{(1-a_H)}{\sqrt{A-2a_H}} = 0$$

$$\phi_3 = -1 + \frac{a_L}{2\sqrt{A-2a_L}} + \frac{(1-a_H)}{2\sqrt{A-2a_H}} + \frac{1}{2}\sqrt{A-2a_L} - \frac{1}{2}\sqrt{A-2a_H} = 0$$

Lengthy calculations (available from the authors) verify that the corre sponding point $a_L = \frac{1}{6}$, $a_H = \frac{11}{18}$ and $A = \frac{4}{3}$ is a global maximum. However, this solution violates (RP), because $\sqrt{A-2a_H} = \frac{1}{3} < k^* = \frac{1}{2}$. Therefore (RP) is binding, so assume $\sqrt{A-2a_H} = \frac{1}{2}$, or $A = \frac{1}{4} + 2a_H$. Substituting this restriction into ϕ, the objective function appears as follows:

$$x(a_L,a_H) = \frac{5}{24} + \frac{1}{2}a_L^2 + \frac{1}{2}a_H - \frac{3}{2}a_H^2 + a_L\sqrt{\frac{1}{4} - 2a_L + 2a_H} + \frac{1}{3}\left[\frac{1}{4} - 2a_L + 2a_H\right]^{3/2}$$

The first-order condition on a_L implies $a_L = a_H - \frac{3}{8}$, or $\sqrt{\frac{1}{4} - 2a_L + 2a_H} = 1$. Substitution into the first-order condition on a_H implies $a_H = \frac{9}{16}$, so $a_L = \frac{3}{16}$ and $A = \frac{11}{8}$. Additional lengthy calculations (available from the authors) verify that this point is a global maximum.

Proof of Proposition 2:

$I_1^{AI}(c_1) = V_1^{AI}(c_1) - V_0^{AI}(c_1) = V_1^{AI}(c_1)$ – constant, so $\dfrac{\partial I_1^{AI}}{\partial c_1} = \dfrac{\partial V_1^{AI}}{\partial c_1}$.

The total value at the end of period one is given below.

$$V_1^{AI}(c_1) = (1-c_1) + \int_0^{k_2(c_1)} [1-k_2(c_1)]\, f(c_2)dc_2 = (1-c_1) + [1-k_2(c_1)]\, F(k_2(c_1))$$

Taking the derivative of $V_1^{AI}(c_1)$ we obtain:

$$\frac{\partial V_1^{AI}}{\partial c_1} = -1 + f(k_2(c_1))\frac{dk_2}{dc_1} - k_2(c_1) f(k_2(c_1))\frac{dk_2}{dc_1} - k_2(c_1)\, F(k_2(c_1))$$

Substituting the truth telling condition $\dfrac{dk_2}{dc_1} = -\dfrac{1}{F(k_2(c_1))}$, provides:

$$\frac{\partial V_1^{AI}}{\partial c_1} = -1 - \frac{f(k_2(c_1))}{F(k_2(c_1))} + \frac{k_2(c_1) f(k_2(c_1))}{F(k_2(c_1))} + 1$$

$$= -\frac{[1-k_2(c_1)]\, f(k_2(c_1))}{F(k_2(c_1))}$$

At a_L, $\dfrac{\partial V_1^{AI}}{\partial c_1} = \dfrac{\partial I_1^{AI}}{\partial c_1} = 0$, since $k_2(a_L) = 1$. Optimality implies $k_2(a_H) = k^*$. But from equation (1), k^* satisfies $(1-k^*)\dfrac{f(k^*)}{F(k^*)} = 1$, so at a_H $\dfrac{\partial V_1^{AI}}{\partial c_1} = \dfrac{\partial I_1^{AI}}{\partial c_1} = -1$.

Finally, the second derivative of V_1^{AI} equals the second derivative of I_1^{AI} and is:

$$\frac{\partial^2 V_1^{AI}}{\partial c_1^2} = \frac{\partial^2 I_1^{AI}}{\partial c_1^2} = \frac{dk_2}{dc_1}\left[\frac{f}{F} - (1-k_2)\frac{\partial\left(\frac{f}{F}\right)}{\partial k_2}\right] < 0 \text{ for } a_L < c_1 < a_H \quad \text{if } \frac{d\left(\frac{F}{f}\right)}{dc_1} > 0.$$

Because $CF(c_1) = 1 - c_1$, $\dfrac{\partial CF}{\partial c_1} = -1$.

So, $\dfrac{\partial I_1^{AI}}{\partial CF} = \dfrac{\partial I_1^{AI}}{\partial c_1}\dfrac{\partial c_1}{\partial CF} = 0$ at $c_1 = a_1$ and $\dfrac{\partial I_1^{AI}}{\partial CF} = 1$ at $c_1 = a_2$.

Because $\dfrac{\partial^2 I_1^{AI}}{\partial c_1^2} < 0$, $0 < \dfrac{\partial I_1^{AI}}{\partial CF} < 1$ for $a_1 < c_1 < a_2$.

Endnotes

1 "The need for development of a rigorous concept of business income, one which rests on sound theoretical underpinnings yet is measurable in practice, is indisputable. Business income is one of the key elements of information upon which the functioning of a private, free enterprise economy depends." (Edwards and Bell 1961, vii)

2 Williamson (1986) considers perquisite consumption to be crucial to a transaction cost theory of the firm: "[Emoluments] refer to that fraction of managerial salaries and perquisites that are discretionary. That is emoluments represent rewards which, if removed, would not cause the managers to seek other employment. They are economic rents and have associated with them zero productivity. Thus they are not a return to entrepreneurial capacity but rather result from the strategic advantage that the management possesses in the distribution of the returns to monopoly power."

3 No participation constraint is included in (P1), because the (RF-1) constraints imply the manager has non-negative expected slack. The assumption that the manager will accept employment for zero expected slack is made for convenience and does not significantly affect the results.

4 The approach used in this model is based on Myerson (1981). See also Baron and Besanko (1984), Baron and Myerson (1982), Besanko (1985), Gibbons (1987), and Kanodia and Mukherji (1994).

5 Lemma 2 relies on the linear structure of the model to the extent that production is efficient in the producing region. More generally, if the revenue function were concave (and cost linear) or revenues linear and cost convex, efficient production would be achieved only at the lowest possible cost and production restricted for all costs between the lowest and the cutoff (Baron and Myerson 1982; Sappington 1983). The simpler linear version of the model facilitates achieving close-form solutions for two period contracts.

6 Thus Coase's theorem does not apply.

7 Thus, when we find a relationship between intertemporal cash flows, we know it is induced by an (investment) response to the information asymmetry.

8 Another interpretation is that a second firm could attract the manager away from the original firm in period 2. This constraint only becomes important in Proposition 2 in section 4.

9 Let production in period i be defined by $1 - c_i$ and slack by $y_1 - c_1$ in period 1 and $k_2 - c_2$ in period 2. Then the objective function is equal to expected production plus slack, and the derivative of the slack terms in the objective function with respect to a_L add to zero.

10 There are other similar dynamic models in the literature that do not restrict second period transfers. For example, Baron and Besanko (1984) consider the case of a regulator and a regulatee who privately observes the cost (see also Gibbons [1987]). They demonstrate that when costs are perfectly correlated across time, the optimal strategy for the regulator is to repeat the optimal one-period contract. The optimal strategy is not characterized by any interesting interperiod relationships. In contrast, when costs are independent, the optimal two-period strategy for the regulator is to allow the regulatee to earn informational rents on his first-period information and to produce efficiently in the second period. Again, the optimal strategy is not characterized by any interesting interperiod relationships. Second period contractual terms are independent of the cost in period one, although long-term contracts are superior to a series of short-term contracts. If the first period cost is imperfectly

informative about the second period cost, Baron and Besanko's contract may exhibit memory, due entirely to a learning effect.

11 This property holds for common densities, such as the uniform, normal and exponential.

12 For example, Feltham and Ohlson (1994) assume cash receipts (CR_t) and investments (CI_t) behave as follows,

$$CR_t = \gamma CR_{t-1} + \kappa CI_{t-1} + \varepsilon_{1t}$$
$$CI_t = \omega CI_{t-1} + \varepsilon_{2t}$$

where $\gamma > 0$, $\omega > 1$ and ε_{ij} are independent random variables with mean zero. Thus, a surprise in cash receipts at time t-1 increases cash receipts at time t through the γ term.

References

Antle, R., and G. Eppen. Capital Rationing and Organizational Slack in Capital Budgeting. *Management Science* (1985), 163–174.

__________ and J. Fellingham. Resource Rationing and Organizational Slack in a Two Period Model. *Journal of Accounting Research* (1990), 1–24.

Baron, D., and D. Besanko. Regulation and Information in A Continuing Relationship. *Information Economics and Policy* (1984), 267–302.

__________, and R. Myerson. Regulating a Monopolist with Unknown Costs. *Econometrica.* (1982), 911–930.

Besanko, D. Multi-period Contracts between Principal and Agent with Adverse Selection. *Economics Letters* (1985), 33–37.

Chambers, R. *Accounting, Evaluation and Economic Behavior.* Prentice Hall, 1966.

Edwards, E., and P. Bell. *The Theory and Measurement of Business Income.* University of California Press, 1961.

Fellingham, J., C. Finger, W. Teets, D. Ziebart. Links between Cash Flow, Accrual Accounting Income, and Economic Income: A Theoretical Model with Supporting Evidence. unpublished, 1995.

Feltham, G., and J. Ohlson. Uncertainty Resolution and the Theory of Depreciation Measurement. unpublished, 1994.

Gibbons, R. Piece-Rate Incentive Schemes. *Journal of Labor Economics* (1987), 413–429.

Hicks, J. *Value and Capital.* Oxford University Press, 1939.

Ijiri, Y. *Theory of Accounting Measurement.* AAA, 1975.

Kanodia, C., and A. Mukherji. Audit Pricing, Lowballing and Auditor Turnover: A Dynamic Analysis. *The Accounting Review* (1994), 593–615.

Myerson, R. Incentive Compatibility and the Bargaining Problem. *Econometrica* (1979), 61–74.

__________. Optimal Auction Design. *Mathematics of Operations Research* (1981), 58–73.

Paton, W. *Accounting Theory.* Accounting Studies Press, Ltd., 1922.

__________ , and A. Littleton. *An Introduction to Corporate Accounting Standards.* AAA, 1940.

Sappington, D. Limited Liability Contracts between Principal and Agent. *Journal of Economic Theory* (1983), 1–21.

Sterling, R. *Theory of the Measurement of Enterprise Income.* University of Kansas Press, 1970.

Williamson, O. *Economic Organization: Firms, Markets and Policy Control.* New York University Press, 1986.